

## Appendix A: Airfield Operational Restrictions, Waivers and Modifications to Standards

The following airfield operational restrictions, waivers and modifications to standards pertain the existing and/or future airfield layout(s) of O'Hare International Airport. Existing restrictions, waivers and modifications to standards were compiled from information provided by the FAA and the City of Chicago's Department of Aviation. This information is current as of December 31, 2002 and is provided for reference only.

- Runway 9L Clear Zone - During Runway 9L arrivals or Runway 27R departures, to protect for the Runway 9L Clear Zone, the section of Taxiway H from Runway 14R-32L Parallel Taxiway T to Taxiway J is unusable. Additionally, aircraft using Runway 32L Parallel Taxiway T should hold south of and north of the Runway 9L RPZ. Aircraft can taxi on Runway 14R-32L however, should hold short of Runway 9L RPZ. – **NOTE: The OMP decommissions Runway 14R-32L and moves the Runway 9L RPZ and Clear Zone west of all taxiways. This restriction to be eliminated with the OMP.**
- Runway 32L Clear Zone - During Runway 14R departures and Runway 32L arrivals with Runway 22L arrivals or departures on the runway or the Runway 4R-22L Parallel Taxiway, to protect for the Runway 32L Clear Zone, the Runway 4R-22L Parallel Taxiway S is unusable from 1500 feet southwest of Taxiway T to 300 feet northeast of Taxiway T. Taxiway T is unusable from Taxiway S to 2200 feet northwest of Taxiway S. – **NOTE: Runway 32L and 32L to be decommissioned and restriction eliminated with the OMP.**
- Runway 27L Clear Zone – During Runway 27L arrivals or Runway 9R departures, to protect for the Runway 27L Clear Zone, aircraft will remain north of the line 450 feet south of the east-west Taxiway D. The Runway 9R-27L Parallel Taxiway M should not be used east of the runway 27L run-up pad. Note: Runway 9R-27L to be renamed Runway 10L-28R
- Runway 27L Clear Zone – During Runway 9R departures with Runway 4R arrivals, to protect for the Runway 27L Clear Zone aircraft departing Runway 9R should be airborne prior to the Runway 4R arrival traffic crossing the threshold. Note: Runway 9R-27L to be renamed Runway 10L-28R
- Runway 4L Clear Zone – During Runway 22R departures or Runway 4L arrivals, to protect for the Runway 4L Clear Zone, the portions of Taxiway W, J, T and Runway 14R-32L within the Runway 4R RPZ are unusable.
- Runway 22L Clear Zone - During Runway 22L arrivals with Runway 22L or Runway 27L departures, to protect for the Runway 22L Clear Zone, the runway 9R-27L Parallel Taxiway M east of the Runway 27L run-up pad in addition to Taxiway D east of the Runway 22L RPZ is unusable. **Note: Runway 9R-27L to be renamed Runway 10L-28R**
- Runway 32R Clear Zone – During Runway 14L Category II/III ILS operations, Runway 14L departures or Runway 32R arrivals, to protect for the Runway 32R Clear Zone, no aircraft may occupy the Runway 32R Hold Pad. – **NOTE: Runway 32R and 32R to be decommissioned and restriction eliminated with the OMP.**

- **Future OMP Runway 28C Clear Zone** – to be established.
- **Future OMP Runway 28L Clear Zone** – to be established.
- Obstacle Identification Surfaces shall be protected at all times regardless of weather conditions. The three defined Obstacle Identification Surfaces located on the airfield are as follows:
  1. The surface west of the Runway 9L end that extends across Parallel Taxiway T and Runway 14R-32L. – **NOTE: The OMP decommissions Runway 14R-32L and moves the Runway 9L RPZ and Clear Zone west of all taxiways. This restriction to be eliminated with the OMP.**
  2. The surface southwest of the Runway 4L-22R end that extends across Taxiway J, T and Runway 14R-32L.
  3. The surface east of the Runway 27L end that extends across Taxiway Q and Runway 22L. **Runway 27L to be renamed Runway 28R.**
- ORD N7110.25. “The distance available to hold short of Runway 27R on “C” and be clear of Runway 22R is 191 feet. Several aircraft exceed that length. Therefore, the following aircraft cannot be clear of both Runways 22R and 27R when instructed to hold short of Runway 27R on “C”: A330, A340, MD11, B777, B767, and all B747. It is noted that the B146 length is 85 feet. It is possible to hold two aircraft similar or smaller in size to the B146 on “C” and still remain clear of both runways. ACTION: Do not issue instructions to aircraft with an overall length of 191’ or greater to hold short of 27R on “C” and conduct simultaneous operations on Runway 22R.”
- Runway 32R Hold Pad – No heavy jets permitted in the Runway 32R Hold Pad.  
**Note: Although Runway 32R will be decommissioned with the OMP project, the Runway 32R Hold Pad will remain in service.**
- Due to converging runway configuration, triple converging approaches are only permissible when weather minimums are 1,000 feet ceiling and 3 nautical mile visibility or better. – **The OMP will be designed to permit triple parallel approaches in all weather conditions.**
- No aircraft may occupy the Runway 4L Hold Pad (Penalty Box) during landings on Runway 4L (or during departures on Runway 22R). Note: Locating Taxiway B within the Runway 4L TERPS approach trapezoid, with no limitation on taxi operations, prevents the existing approach minimums of 400’ ceiling and one mile visibility from being improved, even if instrumentation and lighting upgrading were accomplished.
- Runway 4L Hold Pad (Penalty Box) per Jeppesen Chart 20-9E  
No B747, A330, A340, B777, MD11.

- Runway 4L Hold Pad (Penalty Box) – No heavy jets permitted with the exception of DC-10 and B767.
- Engine run-ups should be conducted in the Ground Run-up Enclosure (GRE). If not available, run-ups can be conducted in the 32L or 9R pads. **NOTE: Runway 32L Hold Pad is demolished and Runway 9R Hold Pad is unusable in the OMP. These restrictions will no longer apply.**
- Runway 32L Hold Pads engine run-ups should not discharge their blasts towards any arriving, departing or taxiing aircraft/ vehicle south of Runway 9R-27L. Runway 9R-27L shall not be used when the run-up is heading 110 degrees clockwise thru 250 degrees. **NOTE: This restriction will be eliminated with the demolition of the Runway 32L pad as proposed in the OMP.**
- Runway 9R hold pad run-ups should be positioned to ensure that no blast is directed towards any arriving, departing or taxiing aircraft/ vehicle. **NOTE: Runway 9R Hold Pad is unusable in the OMP and this restriction no longer applicable.**
- Runway 9L Hold Pad – nothing bigger than a Beech 1900. **Note: Runway 9L Hold Pad to be renamed Runway 9R Hold Pad.**
- **FUTURE HOLD PAD RESTRICTIONS**
  1. **Four new hold pads have been provided, located outboard at the runway ends of Runways 9C-27C and 10C-28C. The Runway 9C, 10C and 28C Hold Pads are planned such that aircraft with wingspans up to but not including 262 feet (ADG-VI) can hold in these pads while providing the required wingtip clearance for ADG-VI aircraft passing by on the parallel taxiways. The Runway 27C Hold Pad is planned for aircraft having wingspans up to but not including 214 feet (ADG-V) while providing the required wingtip clearance for ADG-VI aircraft to pass by on the Runway 27C parallel taxiway.**
  2. **While the existing “27L-22L” Hold Pad (Future “28R-22L” Hold Pad) and Scenic Hold Pad have been reduced in size, they will continue to accommodate aircraft types consistent with current use.**
  3. **The Runway 4R Hold Pad has been reduced in size to accommodate the Future Runway 10R-28L Object Free Area (OFA). As a result, this pad will be restricted to aircraft having wingspans up to but not including 118 feet (ADG-III aircraft and smaller). While holding in the pad, there is sufficient clearance to ADG-V aircraft and smaller (having wingspans up to but not including 214 feet) on Taxiway S and/or an ADG-V aircraft located on the southern entrance taxiway to Runway 28L. Additionally, there is sufficient clearance for ADG-V aircraft to taxi on Taxiway S while another ADG-V aircraft is holding on the entrance taxiway to Runway 28L (hold line located 300 feet south of the Runway 28L centerline).**

4. There are no dimensional changes planned for existing hold pads 14L, 32R, B-Pad, existing 9L pad and the 4L pad (Penalty Box). These pads will accommodate the holding of aircraft consistent with current use.
- When portion of Runway 9L-27R between Runway 18-36 and Taxiway C is not visible from the Tower, ensure that taxiing aircraft do not use T/W H between H1 and C while operations are being conducted on Runway 9L-27R is active. (ASDE III “ghost” images may appear on the runway from aircraft taxiing on TW H). **Note: Runway 9L-27R to be renamed Runway 9R-27L.**
  - ORD N7110.27 (Cancellation Date: 03/10/03). “Runway 18-36 shall not be utilized for arriving or departing aircraft. Runway 18-36 shall only be used for ground movement purposes”. – **NOTE: ORD N7110.27 will no longer be applicable after Runway 18-36 is decommissioned.**
  - Existing Waiver ORD7110.4B: “During the hours of darkness or when the intersection is not visible from the Tower, ORD ATCT is authorized to taxi aircraft into position and hold at the following intersections: 32L(T-10), 32L(M), 27L(M-5) and 14L(U). No arrival operations are permitted while applying the waiver.” – **NOTE: Runway 14R/32L to be decommissioned and Waiver ORD7110.4B to be eliminated with the OMP. Runway 27L waiver will need to be reevaluated.**
  - Simultaneous RW 9R Landings/Crossings. Follow the guidelines in the current FAA and O'Hare LAHSO orders. O'Hare ATCT is authorized to permit aircraft landing on Runway 9R to Hold Short of Taxiway Sierra while aircraft/ vehicles simultaneously cross the runway beyond the hold short point. – **NOTE: Runway 9R to be renamed Runway 10L. After Runway 10L-28R is lengthened to 13,000 feet, the LAHSO hold position will be replaced by Future OMP Runway 10L LDA**
  - A 131' separation exists between parked aircraft and Taxiway A and is appropriate for Aircraft Design Groups I thru IV. Use of Taxiway A by Design Group V aircraft can be accommodated under the terms of a Grant of Exemption to FAR Part 139. The standard separation is 153' **(160' has replaced 153' as the standard)** however, 131' is acceptable subject to the terms of the Exemption. To provide a level of safety equivalent to that of standard 153' **(160' has replaced 153' as the standard)** clearance, airport management must strictly enforce tenant observance of lease lines (physically marked on the pavement) and install and maintain a taxiway centerline system on a portion of Taxiway A (that is less than ADG V standard). The centerline lights in Taxiway A must be operational for certain aircraft to utilize that taxiway. Those aircraft include A330, A340, B747-400, MD11 and B777.
  - B747-400 Restrictions. Ensure two B747-400 series (B74F) do not pass each other while on taxiways Alpha and Bravo. Wing tip clearance does exist for two of these aircraft to taxi pass on the Alpha and Bravo bridges. **This restriction will be expanded to include all aircraft with wingspans equal to or greater than B747-400.**

- When landing Runway 32R, neither the Taxiway B Bridge nor the Runway 32R Bravo Pad shall be used due to intrusion into the Runway 32R Obstruction Free Area. – **NOTE: Runway 32R decommissioned and restriction eliminated with the OMP.**
- B-Pad – No heavy jets permitted in the B Hold Pad until further notice.
- Tower shall not instruct aircraft or vehicles to hold or stop on the portion of Taxiway Romeo that lies between Runways 9L-27R and 4L-22R. – **NOTE: Demolition of Taxiway R is proposed and restriction eliminated with the OMP.**
- Tower shall not instruct a Runway 27R landing aircraft to make a left turn off Runway 27R onto Taxiway Romeo. – **NOTE: Demolition of Taxiway R is proposed and restriction eliminated with the OMP.**
- While on Taxiway A or B, aircraft are not to stop on the bridges.
- K18 pushes back onto a movement area. Prior to approving pushback at K18, ensure taxi operations on Taxiway A are instructed to hold short of Taxiway A17 (northbound) and A19 (southbound).
- **FUTURE RESTRICTION** - Future OMP Runway 9L-27R HAT value of 100-feet for CAT II operations can be achieved for runway to taxiway centerline separation of 400 feet provided taxi operations are restricted to aircraft with wingspans less than 171 feet and tail heights less than 55 feet. Specific restrictions of aircraft on the parallel taxiway to be determined pending results of a FAA collision risk analysis.
- **FUTURE RESTRICTION** - Future OMP Runway 9R-27L CAT II operations – Aircraft restrictions on parallel taxiway to be determined pending results of FAA Aeronautical Study Airspace Case No. 2003-AGL-5-NRA.
- **FUTURE RESTRICTION** - Future OMP Runway 10L-28R CAT II operations – Aircraft restrictions on parallel taxiway to be determined pending results of FAA Aeronautical Study Airspace Case No. 2003-AGL-5-NRA.

## Appendix B: ARFF Response Study

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## **I. Introduction**

This report documents two separate assessments pertaining to the north airfield Aircraft Rescue-Fire Fighting (ARFF) Station #2 at O'Hare International Airport (the Airport). These assessments were conducted in support of the Airport Layout Plan (ALP) for the O'Hare Modernization Program (OMP). The two assessments serve to validate the ARFF facility needs necessary to serve the OMP north airfield development throughout its implementation and ultimate completion.

Both assessments presented herein are predicated on the need to satisfy the minimum ARFF vehicle response times prescribed under Federal Aviation Regulation (FAR) Part 139. FAR Part 139 prescribes the minimum standards that airports must satisfy in order to serve any scheduled or unscheduled air carrier aircraft with more than 30 passenger seats. Among other requirements, it requires that ARFF vehicles demonstrate the ability to reach the midpoint of the furthest runway and commence discharge within three minutes of the first alarm. The assessments do not address the ARFF facility needs associated with other Airport facilities or off-Airport fire-rescue needs.

The initial assessment presented in this document evaluates the ability of ARFF Station #2 to serve future Runway 9L-27R from its current location. It also identifies the additional infrastructure development required to comply with FAR Part 139. This assessment will help define the timing of the eventual relocation of the ARFF station ultimately required by the development of Runway 9C-27C. The assessment presented herein serves as a siting evaluation for the eventual relocation of the ARFF Station #2. It assesses the need to determine the need to develop either one central ARFF facility or multiple ARFF facilities to serve the entire north airfield area under the ultimate configuration. This assessment provides the basis for the ARFF facilities depicted on the ALP.

This report is segregated into five sections. The remainder of Section I provides a brief background and summarize the results of the assessments. Section II summarizes the approach and methodology adopted for the two assessments. It documents data sources, general assumptions, and limitations associated with the analyses. Section III presents the initial assessment of the ability of the existing ARFF Station #2 to satisfy FAR Part 139 minimum response times to Runway 9L-27R. It identifies the preferred ARFF response route to the runway, estimates response times, and identifies proposed infrastructure development needs and costs. The siting analysis for the eventual relocation of ARFF Station #2 is presented in Section IV. This includes the identification of various ARFF relocation sites, identifies recommended ARFF response routes, and estimates the ARFF response times. Section V provides a basic summary of the conclusions made from the two assessments.

### **1.1 Background**

The proposed development of Runway 9C-27C and its north parallel taxiway during Phase 2 of the OMP will require the relocation of the ARFF Station #2. Located within the northwest maintenance area, this station currently serves as the primary ARFF station for the north airfield. The initial draft version of the ALP for the Airport depicted a single replacement site for the north airfield ARFF station, also within the north aircraft maintenance area.

During its initial review of the ALP, the Federal Aviation Administration (FAA) expressed concerns regarding the ability to satisfy the FAR Part 139 minimum emergency ARFF response times from a single north airfield ARFF station location. Of primary concern was the ability to respond to future Runways 9L-27R, 9C-27C, 9R-27L and 4L-22R in compliance with FAR Part 139. Runways 14L-



32R and 14R-32L would also be of concern should the north airfield ARFF station be relocated prior to their closure. ARFF Station #1, currently located in the south cargo area of the airfield, is anticipated to continue to serve the other four runways (Runways 10L-28R, 10C-28C, 10R-28L, and 4R-22L) that would ultimately comprise the south airfield.

Subsequent planning efforts have also focused on the timing of the relocation of ARFF Station #2 and the need to ensure response times are met during all phases of construction. The development of future Runway 9L-27R is of particular concern since its construction would occur during Phase 1, prior to the relocation of ARFF #2 due to the development of future Runway 9C-27C and its parallel taxiway. Therefore, it is prudent to determine if the current location of ARFF Station #2 could satisfy the FAR Part 139 minimum ARFF response times to Runway 9L-27R. Otherwise, the relocation of ARFF Station #2 and/or development of an ancillary station would need to precede the development of Runway 9L-27R.

## **1.2 Assessment Results**

The initial assessment of existing ARFF Station #2 has determined that the FAR Part 139 ARFF response times could be achieved from the existing ARFF Station to future Runway 9L-27R. This would require some infrastructure improvements, including, the development of a dedicated ARFF response road and potential reconfiguration of the vehicular parking area that currently serves the station. Most of these improvements would also facilitate ARFF response times associated with the proposed replacement site of the ARFF Station #2. The costs associated with these infrastructure improvements are estimated to be \$551,500. Based on this analysis, the phased implementation plan for the OMP will allow for the continuing use of the existing ARFF Station #2 once Future Runway 9L-27R becomes operational.

The second assessment concluded that the FAR Part 139 minimum ARFF response times could be achieved from a central ARFF facility location dedicated to serve the north airfield area upon completion of Runway 9C-27C and its north parallel taxiway. The assessment identified three potential sites for the relocated north airfield ARFF station and determined that all three sites could comply with FAR Part 139. **Exhibit 1** illustrates Relocation Alternative 2, identified as the preferred relocation site for ARFF Station #2. This site was selected for its central location, landside and airside access, minimal impact to existing facilities, and minimal infrastructure development needs necessary to comply with FAR Part 139 minimum response times. The proposed relocation of the north airfield ARFF station illustrated on the future ALP has been revised to coincide with that of Alternative 2.

## **II. Approach and Methodology**

Both assessments of the north airfield ARFF station are predicated on the ability to comply with FAR Part 139 minimum response times. This includes the identification and evaluation of dedicated ARFF response routes to the midpoint of each north Airfield runway. The response routes are evaluated in various segments to better assess vehicle acceleration, deceleration, and speed limitations. The time that it takes for ARFF personnel to respond to an alarm, load the response vehicle, and exit the station is also considered.

Initially, response routes were identified that would utilize existing and/or currently planned airfield infrastructure. If a route that would adequately achieve FAR Part 139 response times could not be identified, the assessments then evaluated potential enhancements to ARFF vehicle response time through the development of dedicated ARFF response roads. Additional consideration for development costs associated with additional airfield infrastructure required to satisfy FAR Part 139 requirements is also provided.

### **2.1 Factors Affecting ARFF Response Times**

ARFF response times are dependent on a variety of factors including: ARFF vehicle performance, travel distance and route, and the time required for ARFF personnel to respond to an alarm, load the ARFF vehicle and exit the station. Each of these factors can be quantified. Actual ARFF vehicle performance data was obtained from vehicle manufacturers and interviews with representatives from the Chicago Fire Department and FAR Part 139 Certification Office. The information gathered from each of these sources forms the basis for estimating ARFF vehicle response times.

Other factors that could affect ARFF response times are difficult to quantify without conducting real-time simulations. These other factors may include, but are not limited to: roadway surface conditions, pavement grades, driver technique, vehicle impedance, atmospheric conditions, etc. Two of these factors, pavement conditions and vehicle impedance, are negated during FAR Part 139 certification inspections. This is because FAR Part 139 ARFF vehicle response times are conducted during dry pavement conditions and the airfield is assumed closed to avoid vehicle impedance. The other impacts on ARFF response times, however, are speculative due to the limited availability of information regarding the effects of these factors. Therefore, this assessment does not attempt to quantify them. Instead, the application of ARFF vehicle performance characteristics are adjusted to ensure "conservative" response time estimates in lieu of "optimal" response times. This was achieved by:

- Limiting maximum vehicle speeds to values less than those specified by the manufacturer.
- Utilizing conservative deceleration rates.
- Utilizing conservative estimates for ARFF vehicles to exit the station.
- Assuming that the ARFF vehicle would come to a complete stop before discharging agents.

#### **2.1.1 ARFF Vehicle Performance Characteristics**

The assessment was based on the performance characteristics of the Oshkosh Striker 3000 ARFF vehicle. Although this vehicle is currently not within the ARFF vehicle fleet at ORD, initial conversations with ARFF personnel from the City of Chicago's Fire Department has indicated that this vehicle will be procured by the end of this year (2003). Upon its inclusion in the ARFF vehicle fleet, the Striker 3000 will be the fastest ARFF vehicle within the Airport's fleet.

The Striker 3000 vehicle has a maximum speed of 70 Miles Per Hour (MPH) and accelerates from 0 to 50 MPH within 35 seconds. This translates to an average acceleration of 2.1 feet/sec<sup>2</sup>. Although deceleration rates vary according to driver technique, a conservative deceleration rate of 4.2 feet/sec<sup>2</sup> was assumed. For the purpose of this assessment, a top speed of 60 MPH was also assumed. Cornering speeds were established according to the vehicle turning radii in accordance to the Design Criteria for Preliminary Roadway Design” developed by the American Association of State and Highway and Transportation Officials (AASHTO). The cornering speeds prescribed by AASHTO are summarized in **Table 1**.

**Table 1**

Design Criteria for the Preliminary Roadway Design

Radius of Curve (Feet)	Design Speed (MPH)
150	25
230	30
310	35
430	40
540	45
955	50
1,910	60

Source: American Association of State and Highway and Transportation Officials (AASHTO).  
 Prepared By: Ricondo & Associates, Inc.

### 2.1.2 ARFF Vehicle Staging and Preparedness

The starting position of the ARFF vehicle and the time between the initial alarm and the vehicle's initial movement also affects ARFF vehicle response times. Both assessments assume that the primary ARFF response vehicle would be staged within the truck bay of the ARFF station. The time that it takes for the ARFF vehicle to start traveling after the initial alarm sounds typically varies according to staff preparedness. Recent discussions with the Airport's FAR Part 139 certification inspectors and ARFF personnel indicate that the time required for an ARFF vehicle to exit the station generally varies between 40 and 60 seconds. To ensure a conservative estimate for ARFF response times, the latter time of 60 seconds was assumed for the two assessments contained in this report.

### **III. Existing ARFF Station # 2 Compatibility With Future Runway 9L-27R**

The assessment of the existing north airfield ARFF Station #2 focused on the ability to comply with FAR Part 139 minimum response times to future Runway 9L-27R. A variety of alternatives were evaluated that were predicated on the use of existing and/or planned airfield pavement infrastructure. These included the use of interior service roads within the northwest maintenance area and/or taxiways/taxilanes within the north airfield area. These initial evaluations determined that additional airfield infrastructure would be necessary to satisfy FAR Part 139 minimum ARFF response times to future Runway 9L-27R from the existing ARFF station.

The remainder of this section presents two preferred ARFF routes to Runway 9L-27R from the existing north airfield ARFF station that would comply with FAR Part 139. The primary difference between the two routes is the proposed use of the north or south bays of the ARFF Station #2. The proposed ARFF response routes, estimated ARFF vehicle response times, and infrastructure development needs/costs are also presented.

Preliminary discussions with ARFF personnel indicated that the existing north field station has ARFF vehicle bays located on both the north and south sides of the building. Both bays have adequate depth and height to accommodate the Striker 3000 vehicle. However, the current configuration of the driveway serving the north bay limits the ability to maneuver the larger ARFF vehicles and would most likely preclude the accommodation of the Striker 3000 ARFF vehicle with its present configuration. Should the driveway be reconfigured, it was indicated that this vehicle could be staged in the north bay. On that basis, the assessment of the existing ARFF station evaluates the ability to comply with FAR Part 139 from both the north and south bays of the facility.

#### **3.1 Preferred Response Route**

**Exhibits 2 and 3** illustrate Alternatives IA and IB, the recommended ARFF response routes from the existing north Airfield ARFF station to Runway 9L-27R. The exhibits also present a graphical representation of the estimated ARFF vehicle response speeds and times for Alternatives IA and IB. Alternative IA reflects the recommended ARFF response route from the south bay of the ARFF station, while Alternative IB would utilize the north bay. Although the use of the north ARFF vehicle bay would expedite response to future Runway 9L-27R, reconfiguration of the driveway serving it would be required. The proposed reconfiguration of the driveway serving the north bay is illustrated on **Exhibit 4**.

Both Alternatives IA and IB would require the development of two dedicated ARFF response roadway segments. One roadway segment would expedite the transition between Taxiways E and P by increasing the turn radius to 1,000 feet. This would allow for a maximum ARFF vehicle speed of 50 MPH throughout the turn during dry pavement conditions. An additional roadway segment is proposed that would expedite travel from Taxiway P to the midpoint of Runway 9L-27R. This dedicated ARFF roadway segment would be comprised of a short turn followed by a direct connection to the midpoint of the runway. The turn would have a radius of 2,000 feet, allowing for a maximum speed of 70 MPH during dry pavement conditions, according to the manufacturer of the Striker 3000 ARFF vehicle. To ensure conservative ARFF vehicle response times estimates, a maximum speed of 60 MPH was considered.

The coloring of the ARFF response routes shown on Exhibits 2 and 3 provides correlation with the ARFF vehicle speeds and response times contained in their respective graphs. As shown, the ARFF response time for Alternative IA is estimated at 1 minute-58 seconds. Due to a more direct route and less vehicle turning requirements, the response time for Alternative IB is estimated to decrease to 1 minute-44 seconds. It should be noted, however, that these response times reflect actual vehicle travel times only. The additional time associated with loading the ARFF vehicle and exiting the station is not included. Assuming the additional 60 seconds is required the overall response times for Alternatives IA and IB are estimated to be 2 minutes-58 seconds and 2 minutes-44 seconds, respectively.

### **3.2 Development Considerations**

**Table 2** provides a comparison of the characteristics associated with the two preferred response routes. It summarizes the overall response times, additional roadway infrastructure needs, facility impacts, and infrastructure development cost estimates. As shown, Alternative IA would require the development of 1,700 linear feet of dedicated ARFF response road. In comparison, Alternative IB would require a total of 2,200 linear feet of response road and the relocation of the vehicular parking lot with an overall area of 6,100 square feet. The additional 500 linear feet of roadway and parking infrastructure would be associated with the reconfiguration of the driveway serving the north ARFF vehicle bays.

To enhance operational safety, it is recommended that these roadway segments have an overall width of fifteen feet. Due to its limited use, this roadway would not require curb, gutter or shoulders. Consistent with the cost estimates prepared for similar roadway development projects proposed under the OMP, a unit cost of \$150 per linear foot was assumed to estimate the overall construction cost. The estimated cost to redevelop the parking lot utilizes a unit cost of \$10 per square feet. On that basis, the estimated development costs for Alternative IB exceeds those associated with Alternative IA by approximately \$127,000.

This assessment also considered potential impacts to existing visual and electronic NAVAIDS on the airfield. No significant impacts to existing NAVAIDS were identified. The assessment did not, however, evaluate the potential impact to existing airfield infrastructure items such as airfield lighting and signage, manholes, storm drains, etc. Therefore, it will be necessary to conduct field surveys and site visits prior to the development of the dedicated ARFF response roads and driveway reconfiguration. Potential conflicts with any of these would need to be mitigated, and therefore could affect the implementation and/or development costs.

## IV. North Airfield ARFF Relocation Assessment

The assessment of relocating ARFF Station #2 was also based on the ability to meet FAR Part 139 minimum response times to the north airfield runways. Three alternative sites were identified and evaluated based on site area, line-of-sight clearance from the proposed north airfield Air Traffic Control Tower (ATCT), and landside and airside access capability. **Exhibit 5** illustrates three ARFF station relocation alternatives that were considered for this assessment: Alternatives 1, 2 and 3. **Table 3** summarizes the ARFF vehicle response times for the three alternatives. All three sites satisfy the FAR Part 139 minimum response times to the north airfield runways and provided a clear line-of-sight from the proposed north Airfield ATC Tower.

### 4.1 Relocation Alternative 1

Alternative 1 is located within an existing parking lot immediately north of the intersection of Taxiways E and Y. The parking lot currently serves as employee parking for the tenants within the northwest maintenance area of the Airport. Development of Alternative 1 would require the replacement of this vehicle parking area, preferable in the immediate vicinity. The site provides the opportunity for both immediate airside and landside access.

**Exhibit 6** presents the proposed travel routes to the north airfield runways from Alternative 1 and the estimated ARFF vehicle response times. As shown, the estimated response times would range from 1 minute-55 seconds for future Runway 9C-27C to 2 minutes-43 seconds for future Runway 9L-27R. It should be noted, however, that the response times to future runways 9C-27C and 9R-27L would be predicated in the development of a dedicated ARFF response roadway segment. In addition, the response to Runway 9L-27R would also utilize the dedicated ARFF response road proposed to provide access from existing ARFF Station #2.

### 4.2 Relocation Alternative 2

Alternative 2 would site the ARFF facility immediately west of the intersection of Taxiways E and P. This site currently serves as a deicing vehicle staging area that would likely require relocation. Similar to Alternative 1, the site also provides the opportunity for immediate airside and landside access. It also allows the facility to be oriented on a north-south axis with the vehicle bays on the east side of the station. This would expedite ARFF vehicle response times, as it would minimize turning maneuvers onto Taxiways E and P.

The proposed travel routes to the north airfield runways from Alternative 2 and the estimated ARFF vehicle response times are illustrated on **Exhibit 7**. As shown, the estimated response times would range from 2 minutes-14 seconds for Runway 4L-22R to 2 minutes-55 seconds for future Runway 9L-27R. With the exception of the dedicated ARFF response roadway serving future Runway 9L-27R, these response times are not predicated on the development of additional roadway infrastructure.

### 4.3 Relocation Alternative 3

The ARFF facility would be located immediately south of the intersection of Taxiway P and G under Alternative 3. Currently, this site is vacant; therefore, no facility impacts are anticipated. Although the site provides the opportunity for immediate airside access, direct landside access would not be

provided. This would complicate access to the site, and requires consideration for the transportation of ARFF personnel and visitors via the secured airfield.

**Exhibit 8** illustrates the proposed travel routes to the north airfield runways from Alternative 3 and the estimated ARFF vehicle response times. As shown, the estimated response times would range from 2 minutes-10 seconds for Runway 4L-22R to 2 minutes-33 seconds for future Runway 9L-27R. These response times are also predicated on the development of the dedicated ARFF response roadway to future Runway 9L-27R only.

#### **4.4 Preferred Relocation Alternative**

Relocation Alternative 2 was selected as the preferred relocation site for ARFF Station #2 and is depicted on the ALP. This site was selected for its central location, landside and airside access capability, minimal impact to existing facilities, and minimal infrastructure development needs necessary to comply with FAR Part 139 minimum response times. This will, however, require the relocation of the deicing vehicle staging area. This facility could be accommodated immediately southeast of Taxiway G in close proximity to the scenic hold pad. In comparison, Relocation Alternative 1 was not selected due to its impact on the existing tenant automobile parking areas and the need for the development of additional dedicated ARFF response roadway segments. The inability to provide direct landside access and potential difficulty providing utilities to Relocation Alternative 3 precluded its selection.

## **V. Conclusion**

The proposed development of future Runway 9C-27C and its north parallel taxiway is predicated on, among other things, the relocation of the ARFF Station #2. Currently serving the north airfield, this station's ability to adequately comply with FAR Part 139 ARFF minimum response times to all existing and proposed runways has been questioned. On that basis, the preceding assessments were conducted. These assessments have demonstrated the ability to serve new Runway 9L-27R from the existing ARFF #2 facility in the initial phase of airfield development, and the redeveloped north airfield from a single ARFF station site (Alternative #2).

The ability to respond to future Runway 9L-27R from the existing ARFF Station in compliance with FAR Part 139 has been demonstrated with the development of dedicated ARFF roadway segments. Therefore, the relocation of ARFF Station #2 may be delayed until after runway 9L-27L is constructed without requiring the development of a supplemental ARFF station.

It was also determined that compliance with FAR Part 139 minimum ARFF response times to the north airfield runways could be achieved from a single north airfield ARFF station site. The dedicated ARFF response roads necessary to adequately serve Runway 9C-27C from the existing ARFF Station #2 would serve to expedite response times from the proposed relocation site. On that basis, the future ALP includes a single relocation site and the development of dedicated ARFF response roadway(s) to serve future Runway 9L-27R.



**Table 2**

ARFF Response Route Comparison - ARFF Station #2 Response to Runway 9L/27R

	Alternatives	
	IA <sup>1/</sup>	IB <sup>2/</sup>
<b>Estimated Response Time<sup>3/</sup></b>	2 min. 58 sec.	2 min 44 sec
Complies with Part 139	Yes	Yes
<b>Dedicated Response Road</b>		
Infrastructure (LF)	2,830	3,270
<b>Potential Facility Impacts</b>		
Modification to Driveway/Parking Areas (SF)	0	6,100
<b>Total Estimated Infrastructure Costs<sup>4/</sup></b>	\$424,500	\$551,500
<b>Recommended Action</b>	To be Considered	To be Considered

<sup>1/</sup> Alternatives IA and assumes ARFF vehicle (Striker 3000) would be staged in the truck bays located on south side of the station.

<sup>2/</sup> Alternatives IB and assumes ARFF vehicle (Striker 3000) would be staged in the truck bays located on north side of the station.

<sup>3/</sup> The ARFF response route begins at ARFF station #2 and ends at the midpoint of Runway 9L027R. Assumes 60 seconds between the initial alarm the the truck roll out.

<sup>4/</sup> Unit costs of \$150 per linear foot of fifteen feet wide roadway and \$10 per square foot of parking lot . Of the total infrastructure costs incurred, it has beend estimated that approximaltey \$292,500 would be incurred under ARFF Relocation Alternative 2 to satsify FAR Part 139 response times to Runway 9L-27R.

Source: OMP Cost Estimates; Ricondo & Associates, Inc.

Prepared By: Ricondo & Associates, Inc.

**Table 3****Comparison of ARFF Vehicle Response Times - ARFF Station #2 Relocation Alternatives**

<b>Runway</b>	<b>ARFF Relocation Alternatives <sup>2/</sup></b>		
	<b>1</b>	<b>2</b>	<b>3</b>
<b>9L-27R <sup>1/</sup></b>	2 min. 43 sec.	2 min. 21 sec.	2 min. 33 sec.
<b>9C-27C</b>	1 min. 55 sec. <sup>1/</sup>	2 min. 50 sec.	2 min. 47 sec.
<b>9R-27L</b>	2 min. 40 sec.	2 min. 55 sec.	2 min. 51 sec.
<b>4L-22R</b>	2 min. 5 sec.	2 min. 14 sec.	2 min. 10 sec.

<sup>1/</sup> Provides consideration for dedicated ARFF response road to Runway 9L-27R.

<sup>2/</sup> Assumes 60 seconds between the siren ring and truck roll out.

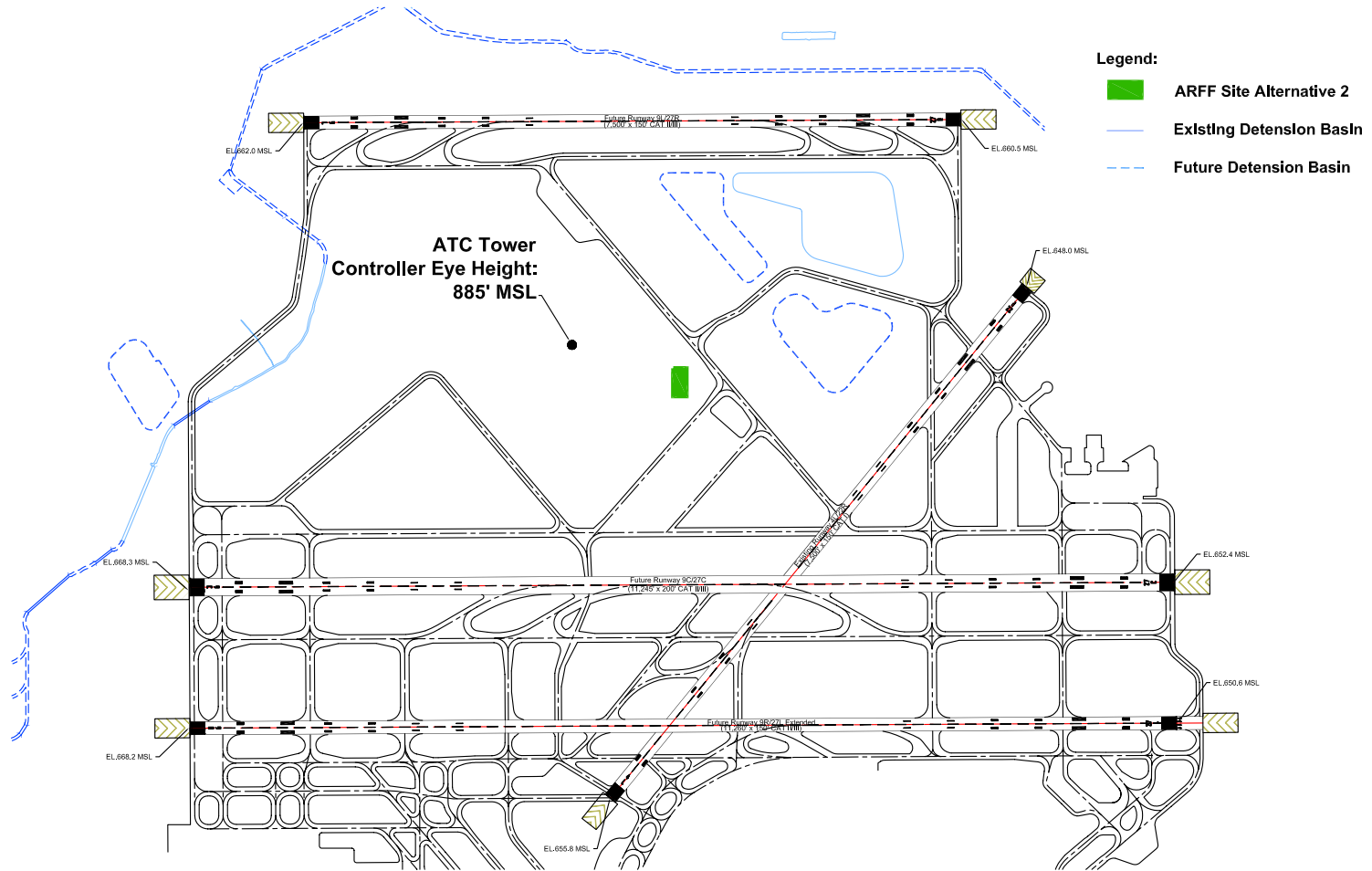
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Source: Ricondo & Associates, Inc.

Prepared By: Ricondo & Associates, Inc.

*Preliminary Draft  
For Discussion Purposes Only*

*O'Hare International Airport*



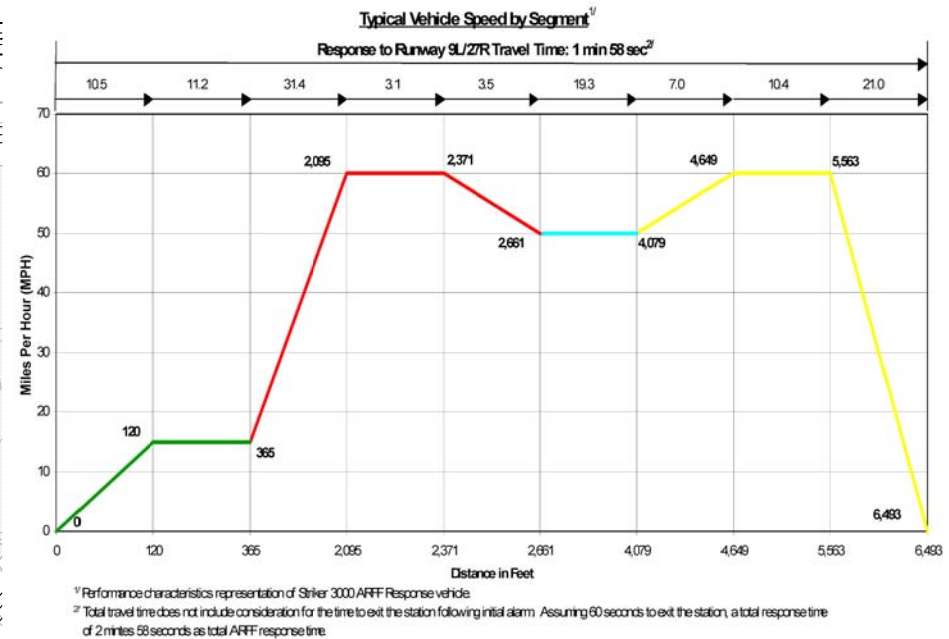
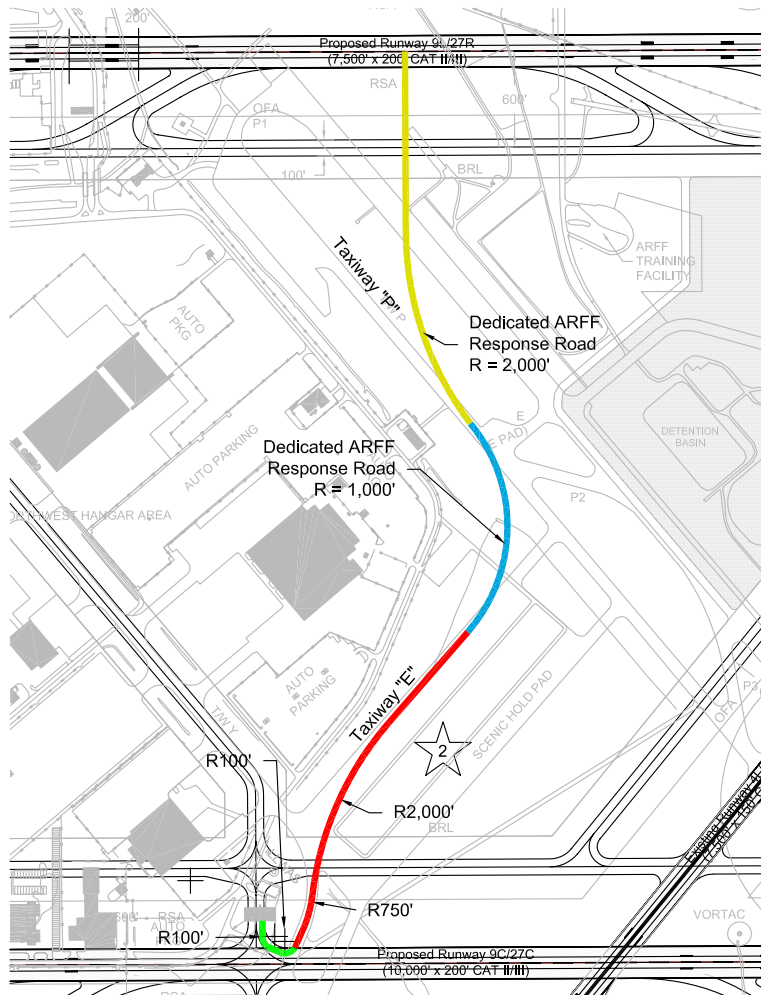
Source: Ricondo & Associates, Inc.  
Prepared by: Ricondo & Associates, Inc.

**Exhibit 1**



**Preferred Relocation Alternative  
North Field ARFF Station #2**

October 17, 2003



**Legend:**

- Vehicle Maneuver onto Twy "E"
- Travel Along Twy "E"
- Transition between Twy "E" and "P"
- Travel Along Dedicated ARFF Response Road

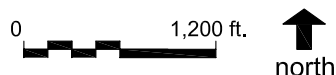
**Maximum Turning Speeds**

Turn Radius	Max Speed
100'	15 MPH
1,000'	50 MPH
2,000'	60 MPH

Source: Oshkosh Truck Corporation; Ricondo & Associates, Inc.  
 Prepared by: Ricondo & Associates, Inc.

Exhibit 2

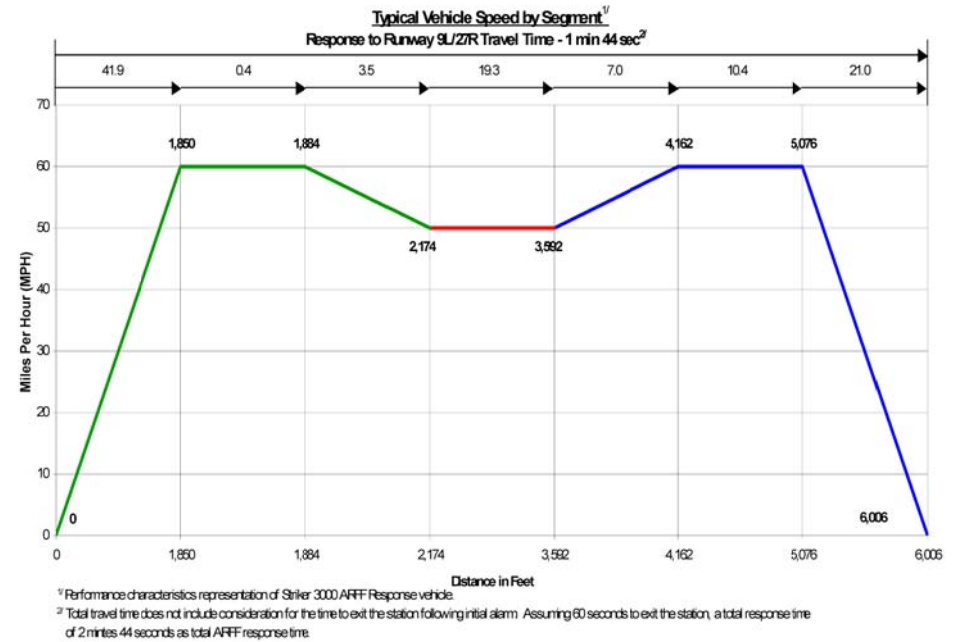
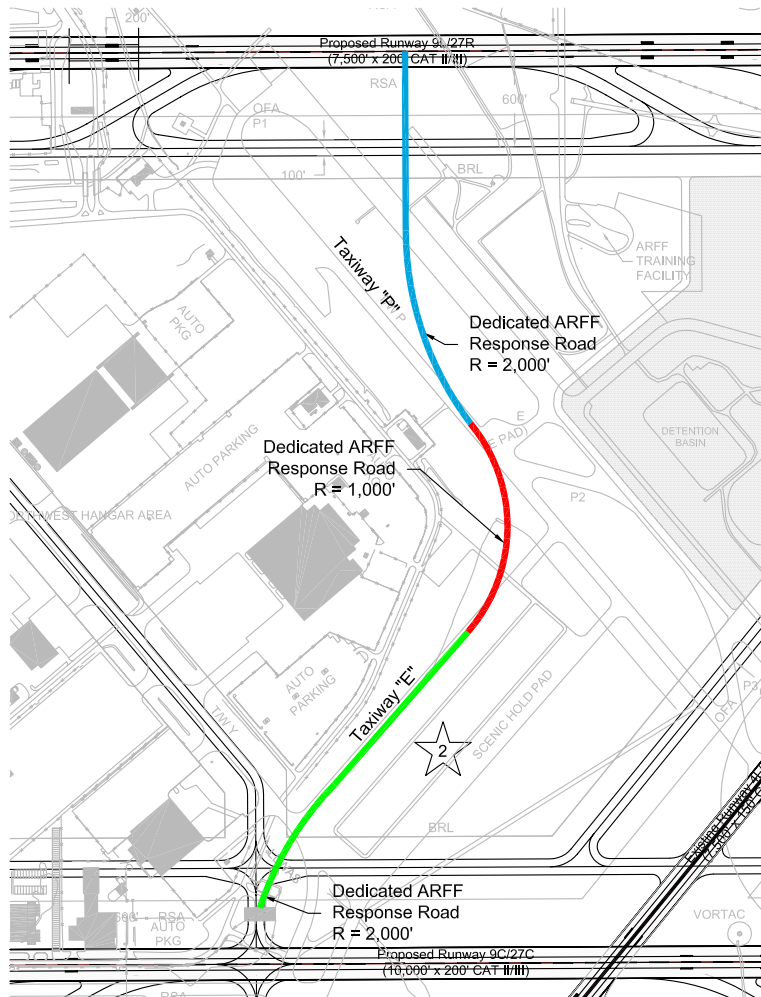
# ARFF Response Route and Travel Time Summary Alternative IA



P:\O'hare\Airfield Planning\ARFF Response Times\Runway 9L-27R\ORD-ARFF Route Alternatives.dwg

Aircraft Rescue and Firefighting (ARFF)  
 Station #2 Analysis

October 17, 2003



**Legend:**

- Travel Along Twy "E"
- Transition between Twy "E" and "P"
- Travel Along Dedicated ARFF Response Road

**Maximum Turning Speeds**

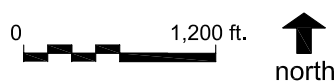
Turn Radius	Max Speed
100'	15 MPH
1,000'	50 MPH
2,000'	60 MPH

Exhibit 3

## ARFF Response Route and Travel Time Summary Alternative IB

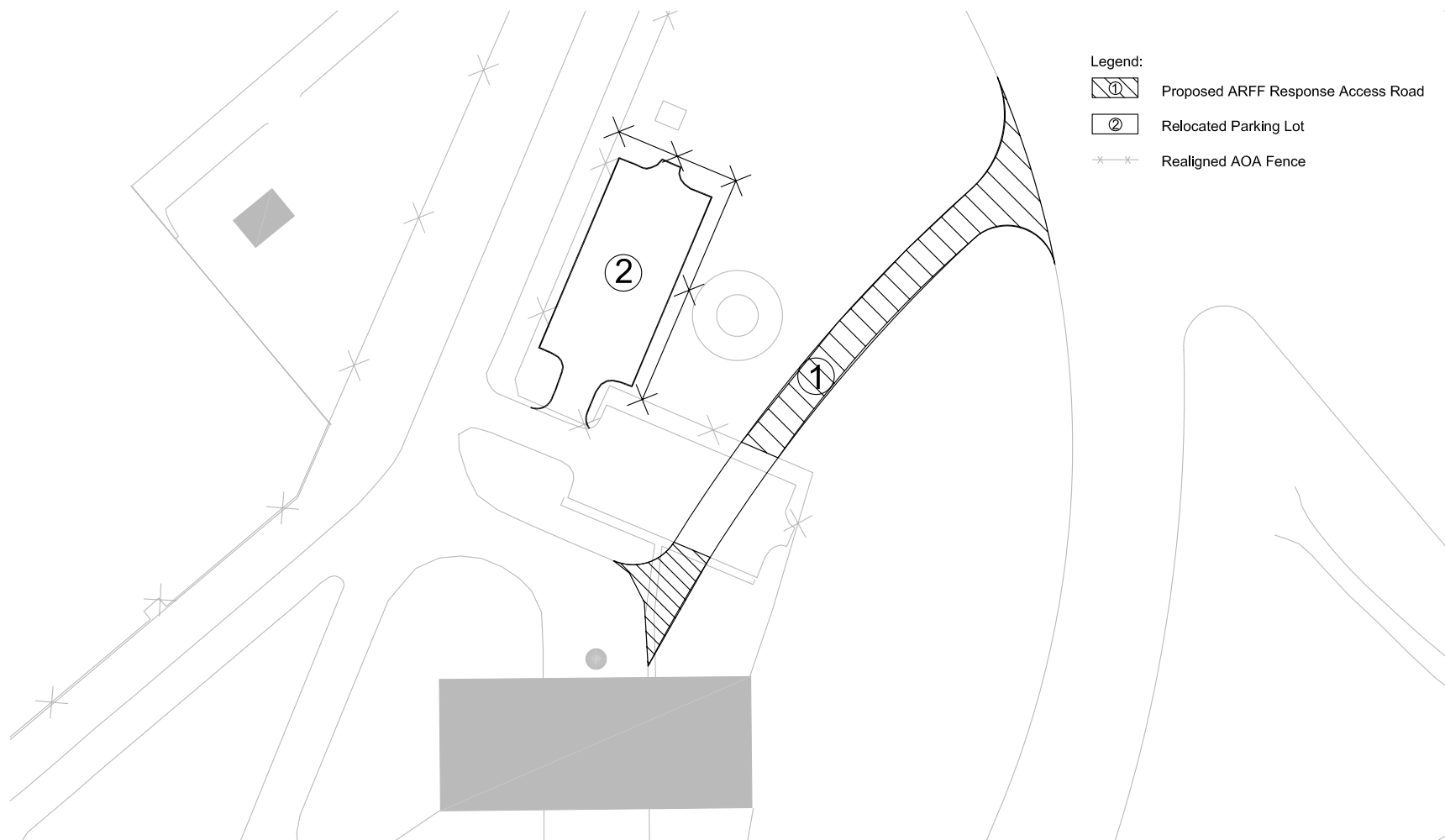
October 17, 2003

Source: Oshkosh Truck Corporation; Ricondo & Associates, Inc.  
Prepared by: Ricondo & Associates, Inc.



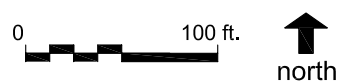
P:\O'hare\Airfield Planning\ARFF Response Times\Runway 9L-27R\ORD-ARFF Route Alternatives.dwg

Aircraft Rescue and Firefighting (ARFF)  
Station #2 Analysis



Source: Oshkosh Truck Corporation; Ricondo & Associates, Inc.  
Prepared by: Ricondo & Associates, Inc.

**Exhibit 4**

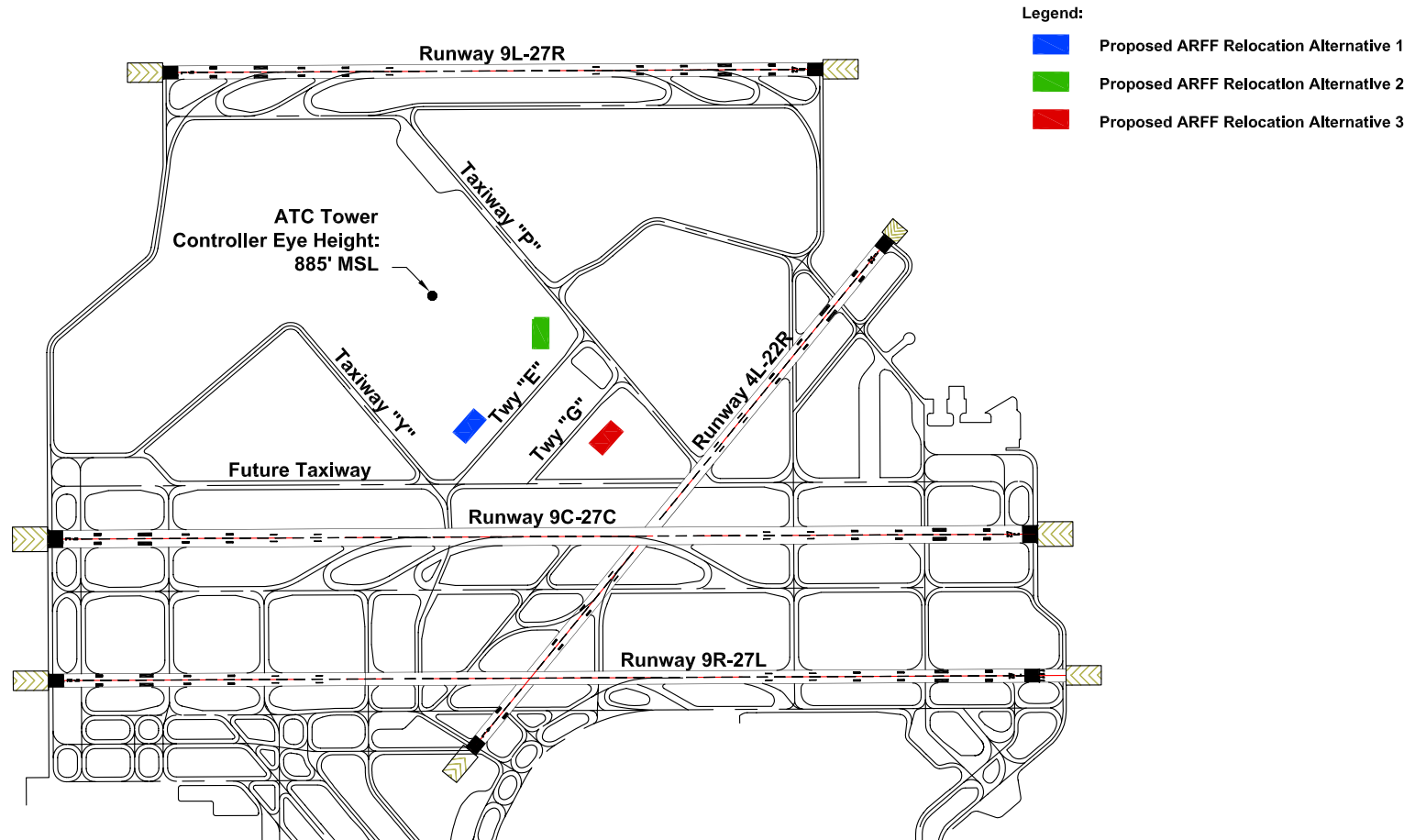


## **Proposed ARFF Access Road/ Relocated Parking Lot**

P:\O'hare\Airfield Planning\ARFF Response Times\Runway 9L-27R\ORD-ARFF Parking Lot.dwg

**Aircraft Rescue and Firefighting (ARFF)  
Station #2 Analysis**

October 17, 2003



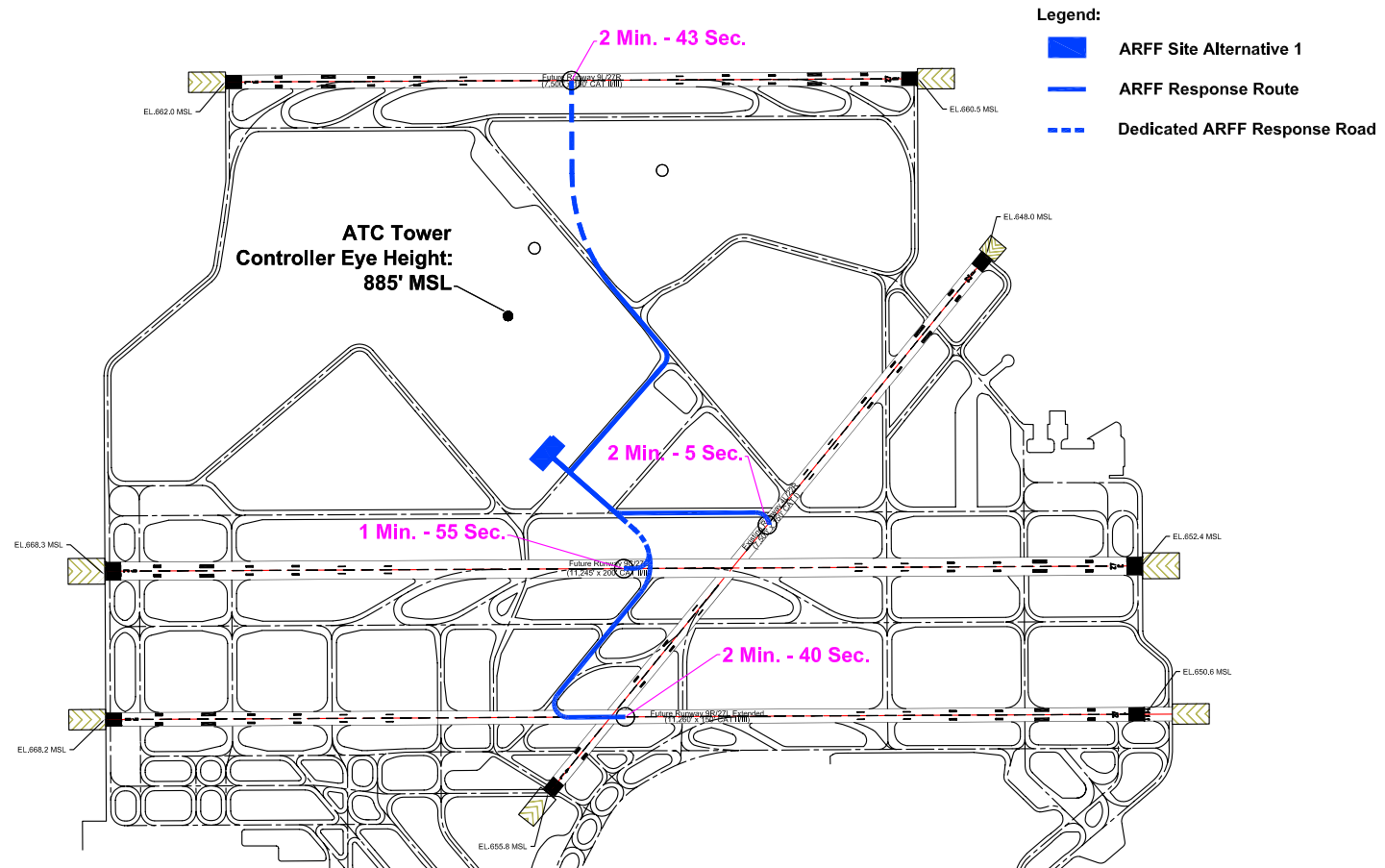
Source: Ricondo & Associates, Inc.  
Prepared by: Ricondo & Associates, Inc.

Exhibit 5



## Proposed ARFF Relocation Alternatives

October 17, 2003



Note: It is assumed that 60 seconds are required from the time the sirens ring to the time the truck rolls.

Source: Ricondo & Associates, Inc.  
Prepared by: Ricondo & Associates, Inc.

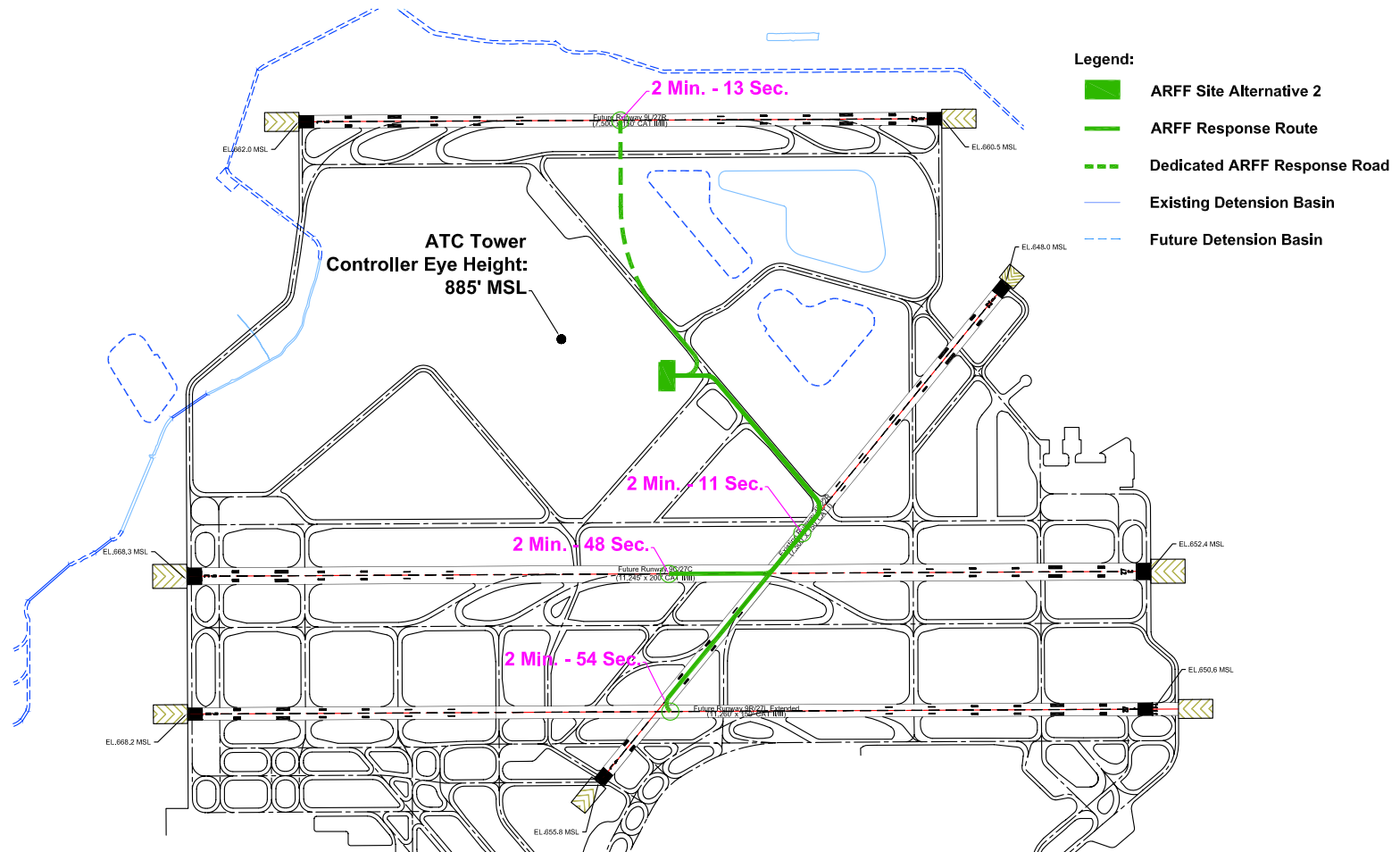
**Exhibit 6**

**FAR Part 139 Emergency Vehicle Response Routes  
ARFF Station #2 (North Field)  
Relocation Alternative 1**



October 17, 2003





Note: It is assumed that 60 seconds are required from the time the sirens ring to the time the truck rolls.

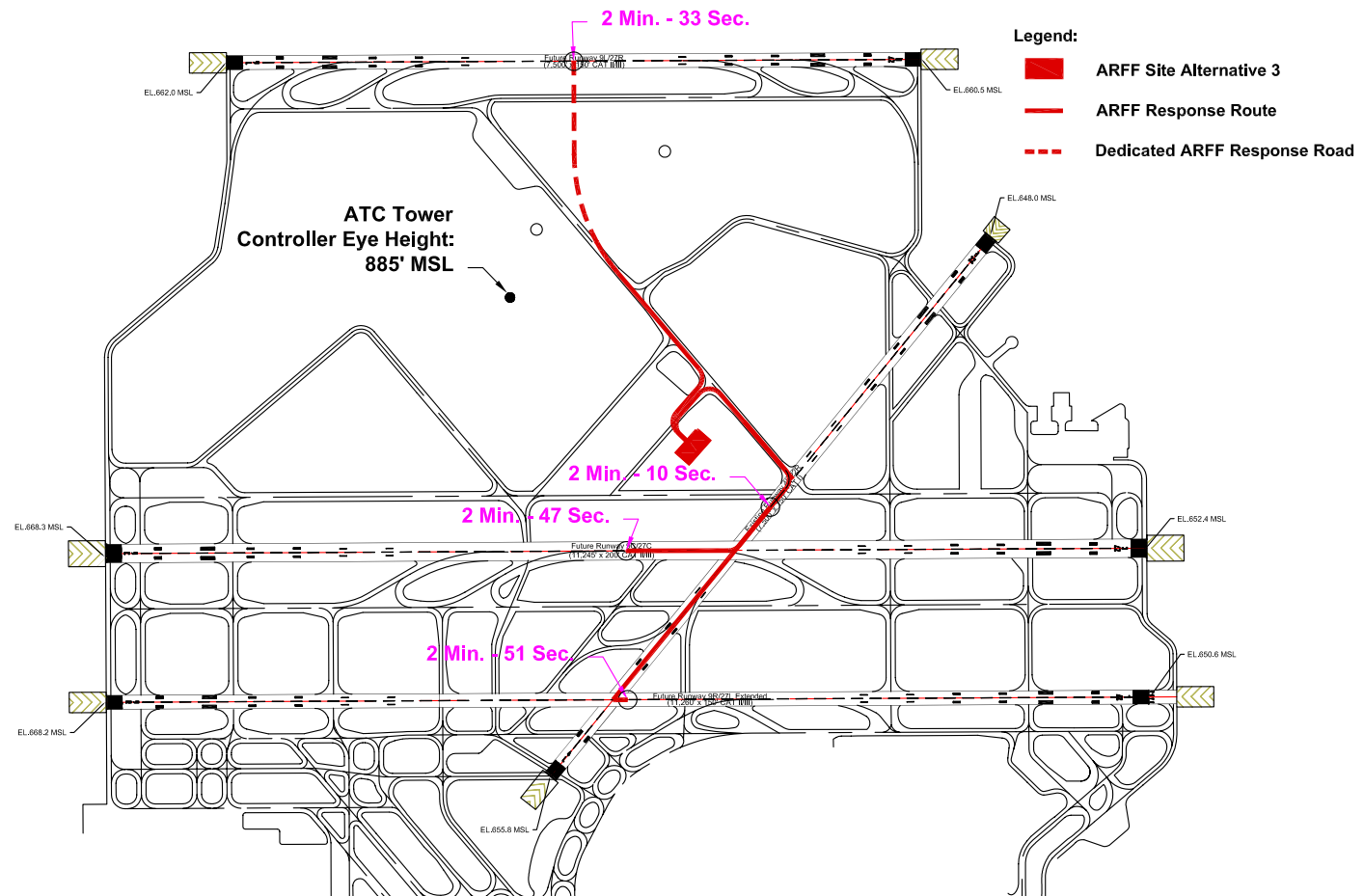
Source: Ricondo & Associates, Inc.  
Prepared by: Ricondo & Associates, Inc.

**Exhibit 7**

## **FAR Part 139 Emergency Vehicle Response Routes ARFF Station #2 (North Field) Relocation Alternative 2**

0 2000 ft.   
north

October 17, 2003



Note: It is assumed that 60 seconds are required from the time the sirens ring to the time the truck rolls.

Source: Ricondo & Associates, Inc.  
Prepared by: Ricondo & Associates, Inc.

**Exhibit 8**

**FAR Part 139 Emergency Vehicle Response Routes  
ARFF Station #2 (North Field)  
Relocation Alternative 3**



October 17, 2003

## Appendix C: Future Runway 28R To Parallel Taxiway Separations

This appendix reviews issues surrounding the geometry proposed on the ALP for the area between the future Runway 28R end and the Terminal 5/Terminal 6 area. Specifically, issues surrounding the proposed addition of a parallel taxiway, and the associated rerouting of the service road and snow road are discussed.

Within the existing airfield, the area immediately north of the approach end of existing Runway 27L (renamed Runway 28R on the ALP) contains two taxiways to facilitate movements of aircraft under air traffic control, and a taxilane to serve the apron area of Terminal 5. The southernmost taxiway (Taxiway M) serves as the parallel taxiway to the runway at a centerline spacing off the runway of 500 feet. Taxiway D is located 553 feet north of Taxiway M, with the area between occupied by two roadways (a Service Road and a Snow Road) and a number of support facilities including the Lockheed Maintenance Facility, a Truck Fuel Stand, an Airline Glycol Facility, and the Super Fuel Satellite. The Existing ALP depicts these conditions. Currently both Taxiway M and D are used under certain operating configurations to feed traffic to existing Runways 22L and 27L for departures. The Terminal 5 taxilane is used to provide egress to/from Terminal 5 gates.

As part of the expansion of Terminal 5 and development of Terminal 6 proposed under the World Gateway Program (WGP), the need for an additional taxiway in this area was defined. Under this plan, two taxiways would continue to provide departure feeds for Runways 22L and 27L, while an additional taxiway would be provided to facilitate movements to/from the Terminal 6/Terminal 5 area in support of the existing taxilane. To accommodate the additional taxiway within the available area, the WGP proposed combining the function of the Snow and Service roads and narrowing the runway to parallel taxiway centerline spacing to 400 feet within the area. The proposed taxiway/roadway pattern illustrated on the Future ALP is similar in concept to that proposed by the WGP, but the Service Road was shifted from between the two taxiways providing feed to the runways, to between the next pair of taxiways to the north.

Two apparent issues were anticipated as part of the above reconfiguration, specifically: 1) the need for and acceptability of having a Service Road essentially embedded within a parallel set of three taxiways and one taxilane, and 2) the impacts of narrowing the runway to parallel taxiway centerline spacing from 500 feet to 400 feet to accommodate a service road.<sup>1</sup> The following addresses each of the above issues.

The concept of four taxiways with the proposed roadway reconfiguration as depicted on the Future ALP is illustrated on **Exhibit A**. The easternmost element of the service road is shown at 66 feet in width to accommodate the snow equipment staging function<sup>2</sup>. **Exhibit B** illustrates the ability to provide three Group V taxiways and a taxilane in this area, without narrowing the existing runway to

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<sup>1</sup> FAA TIL 00005A Minimum CAT II HAT values can be achieved with taxiway centerline to runway centerline separation of 400 feet provided taxiway operations are restricted to aircraft having wingspans less than 171 feet and tail heights less than 55 feet. Larger aircraft taxiing on the parallel taxiway (i.e. wingspans equal to or greater than 171 feet and tail heights equal to or greater than 55 feet) would require a collision risk assessment to determine the minimum HAT value.

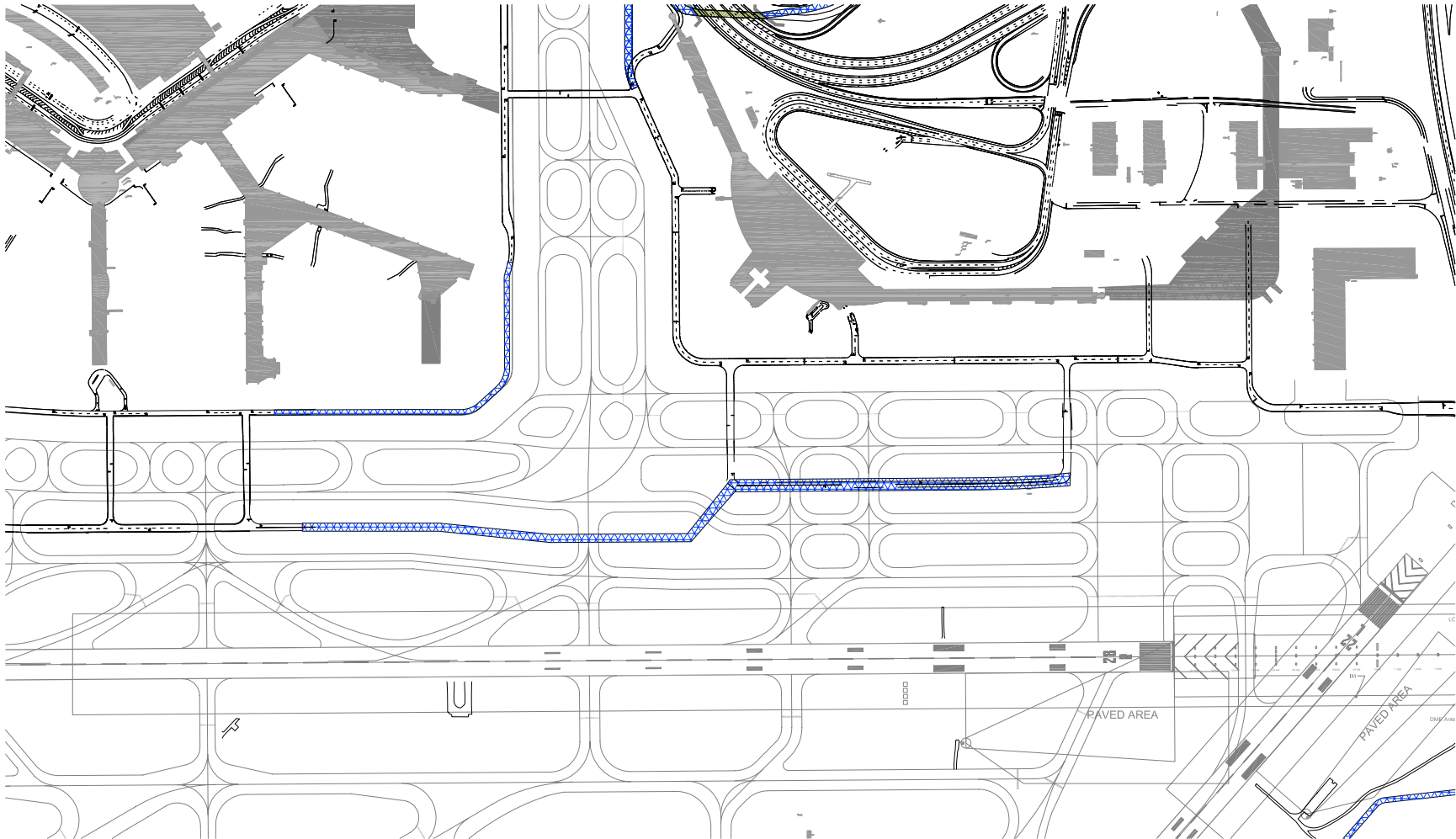
<sup>2</sup> It has since been determined that an opportunity exists to use various airfield pavements (such as the Runway 28C hold pad) for future snow equipment staging. Subsequently this roadway section has been reduced, however the need for this pavement for other service vehicle movements would still remain.

parallel taxiway spacing (e.g., 500 ft.), but the available area does not provide adequate space for a service road. Vehicle traffic flows currently accommodated by the Service Road would be shifted onto the Terminal 5/6 apron edge Service Road outboard the tails of parked aircraft.

Regardless of the need for four taxi routes to support Terminal 5/6 operations as proposed under WGP, **Exhibit C** documents the need for four taxi routes to support future OMP airfield movements as developed under the on-going simulation work. A review of Exhibit C shows existing Taxiway M has eastbound traffic feeding Runway 28R intersection departures while the taxiway immediately to its north has westbound traffic accommodating returning traffic from Runway 28C landings that cross behind the Runway 28R departures. The third taxiway to the north (existing Taxiway D) has eastbound traffic feeding Runway 22L departures. These taxi flow patterns are representative of anticipated high-use operating configurations.

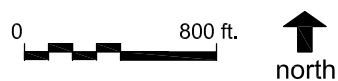
Given the documented need for adding a taxiway either in support of the Terminal 5/6 or OMP airfield development, the issue is which service road pattern better satisfies vehicular traffic flow requirements and which pattern better interfaces with aircraft operations. **Exhibit D** (with Service Road Plan) and **Exhibit E** (without Service Road Plan) provide a comparison of how traffic volumes might be accommodated under the two roadway concepts using existing peak hour vehicular traffic volumes as concluded by the Service Road Study. The traffic flows and volumes indicated on Exhibit D closely represent that observed for the existing airfield in the area for a Peak Hour 1:00pm – 2:00pm period. A review of Exhibit D shows the roadway element identified as Realigned Tank Farm Road accommodates a peak of 78 westbound and 81 eastbound movements. By contrast, Exhibit E shows these 78 and 81 movements utilizing the Terminal 5 ramp edge service road and crossing Taxiways A, B and the Terminal 5 Taxilane immediately west of Terminal 5. The crossing of these taxiways/taxilane at this location would be highly undesirable given there is no refuge area to safely hold between the taxiways, and roadway geometry on each side of the crossing makes visibility of aircraft movements much more difficult. Additionally, the rerouting of roadway traffic in the manner illustrated on Exhibit E considerably increases (by 50 movements in each direction) traffic volumes on the service road adjacent to Terminal 3 Concourses H and K). The use of the existing service road crossing of Taxiways A and B to the north, opposite the existing Delta Airlines Concourse, does not appear to be present a better alternative. While the service road location shown on Exhibit D may be considered less than ideal, it does highlight the need for a service road in the area.

Given the demonstrated desire for a minimum of four taxi flows and the service road, the issue then relates to the 400 feet versus 500 feet of runway to parallel taxiway centerline separation for a Group V runway. Existing Runway 27L (future 28R) is expected to become CAT II/III capable in the near future. Runway 10C-28C is programmed to come on line in the year 2009 time frame as a CAT II/III runway in both directions. When Runway 10C-28C opens, Runway 28C will become a primary landing runway under west flow VFR/IFR conditions and Runway 28R will be used primarily for departures, consistent with the taxi flows discussed previously. On this basis, CAT II/III on Runway 28R would likely be used in limited periods as an alternate to Runway 28C, but would be available, if needed. Under such future conditions, during the limited periods when CAT II/III arrivals would occur on Runway 28R, the 400-foot spaced taxiway would be restricted to ADG IV aircraft or smaller. Alternatively, a collision risk assessment may determine that operations on this taxiway by larger aircraft (i.e. aircraft with wingspans equal to or greater than 171 feet and tail heights equal to or greater than 55 feet) would not adversely impact CAT II approach minimums.



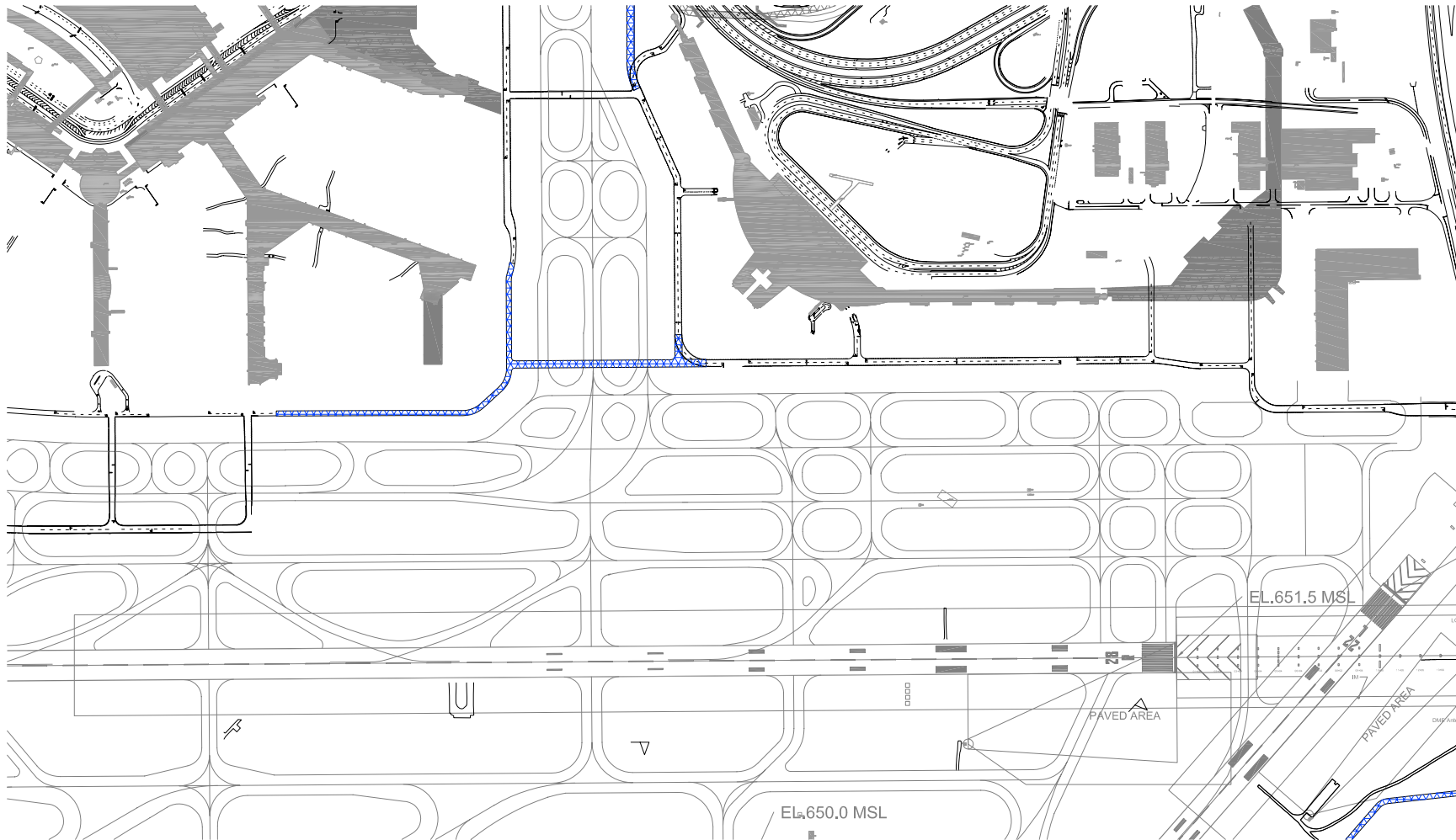
Source: Ricondo & Associates, Inc.  
Prepared by: Ricondo & Associates, Inc.

Exhibit A



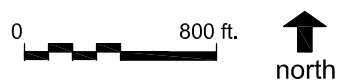
## Four Taxiways With Proposed Service Road Plan

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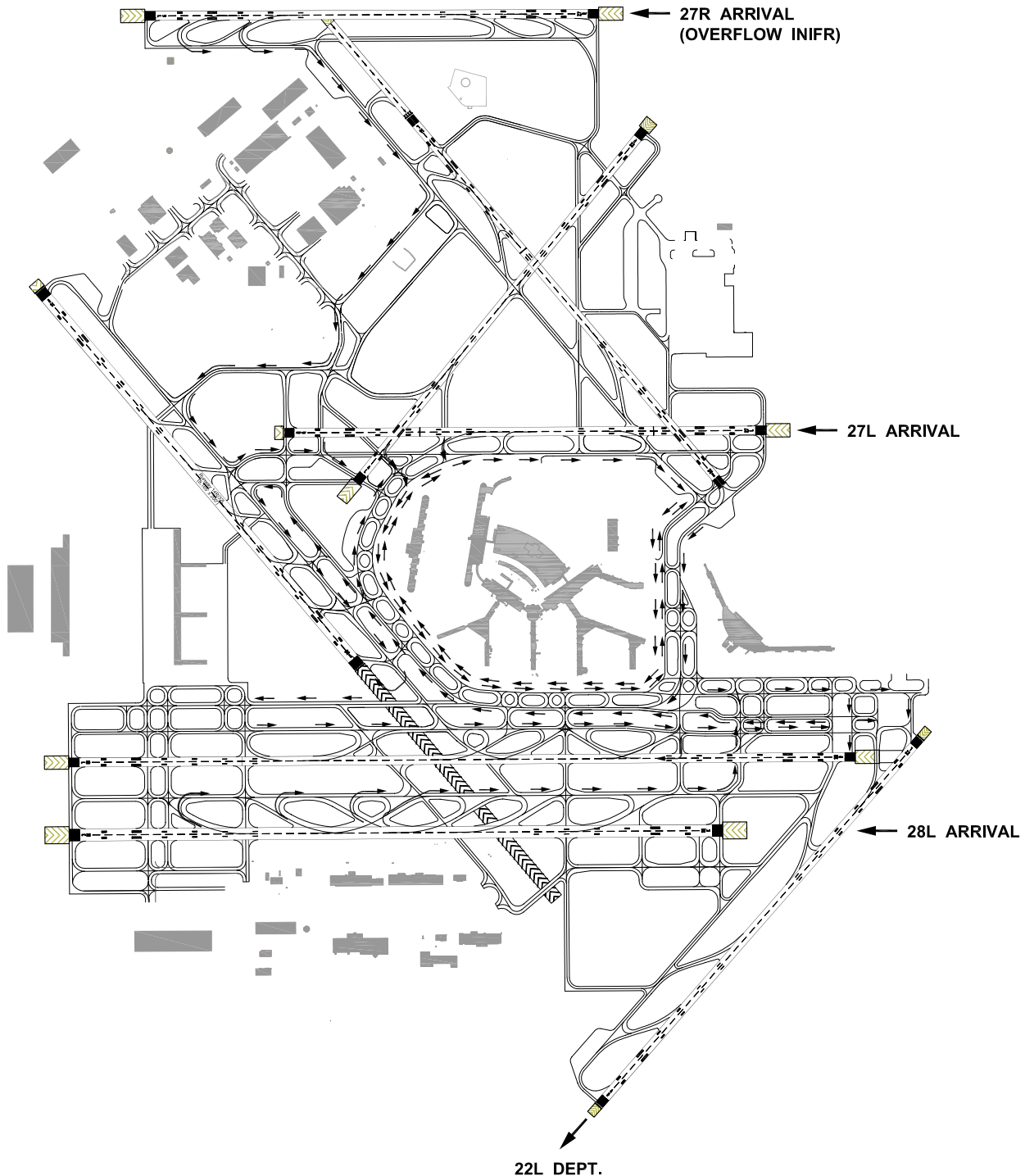
Source: Ricondo & Associates, Inc.  
Prepared by: Ricondo & Associates, Inc.

Exhibit B



## Four Taxiways Without Proposed Service Road Plan

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Source: Ricondo & Associates, Inc.  
Prepared by: Ricondo & Associates, Inc.

Exhibit C

0 2600 ft.  
↑  
north

**FUTURE AIRPORT DRAWING**  
**Analysis year 2009 IFR 27's**  
**VFR Parallel 27's & IFR 27's**

Z:\Chicago\ORD\OMP\ALP-DrawingSet-FINAL\ServiceRoad-AltLayouts\OMP-2009-2-ExhibitC.dwg



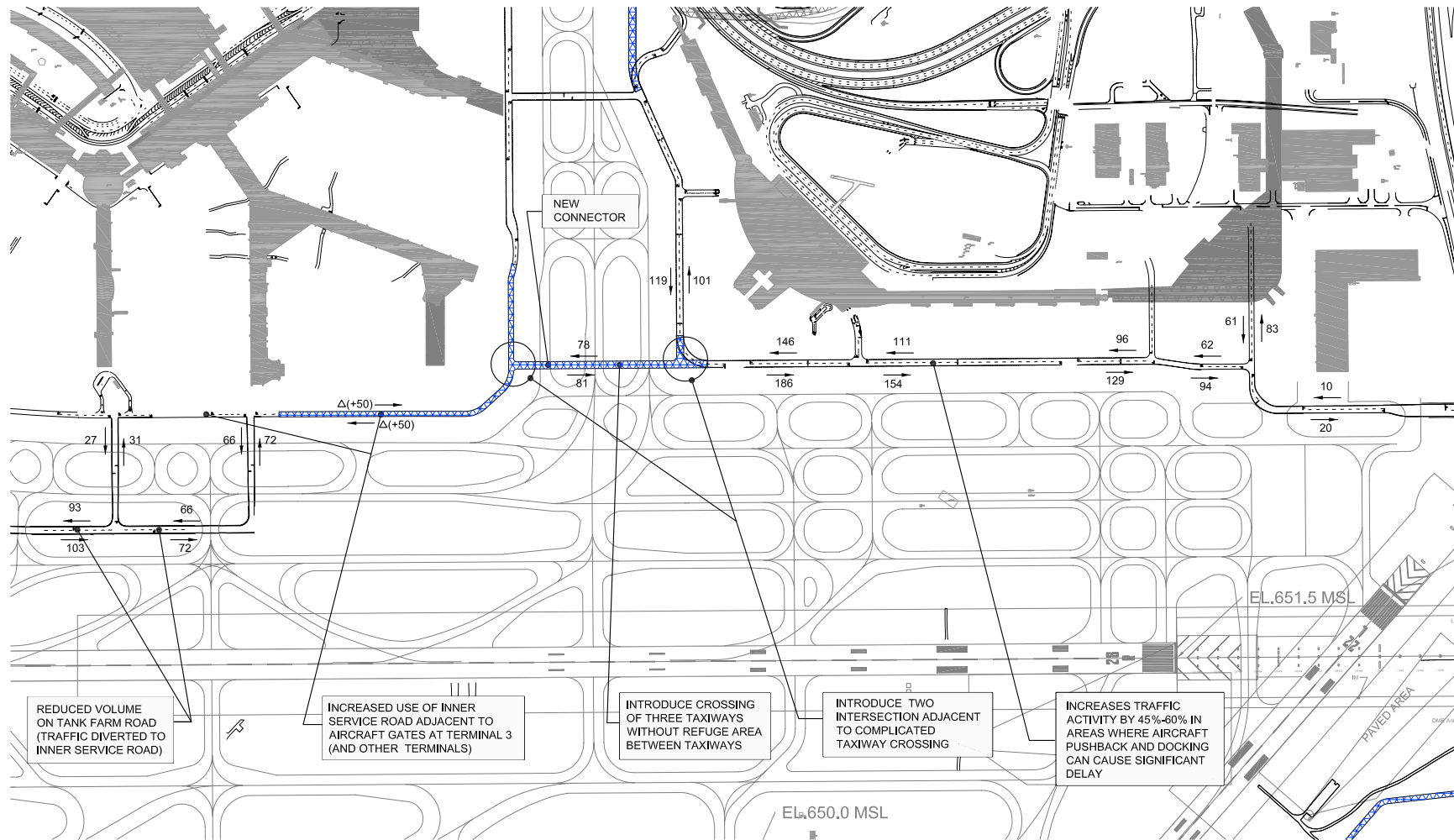
Exhibit D



## O'Hare Modernization Program

September 15, 2003





Source: Ricondo & Associates, Inc.  
Prepared by: Ricondo & Associates, Inc.

Exhibit E

## Existing Peak Hour Traffic Flow Without Proposed Service Road Plan

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## **Appendix D: Hold Pads**

Four new hold pads have been provided, located outboard at the runway ends of Runways 9C-27C and 10C-28C. The Runway 9C, 10C and 28C Hold Pads are planned such that aircraft with wingspans up to but not including 262 feet (ADG-VI) can hold in these pads while providing the required wingtip clearance for ADG-VI aircraft passing by on the parallel taxiways. The Runway 27C Hold Pad is planned for aircraft having wingspans up to but not including 214 feet (ADG-V) while providing the required wingtip clearance for ADG-VI aircraft to pass by on the Runway 27C parallel taxiway.

While the existing "27L-22L" Hold Pad (Future "28R-22L" Hold Pad) and Scenic Hold Pad have been reduced in size, they will continue to accommodate aircraft types consistent with current use.

The Runway 4R Hold Pad has been reduced in size to accommodate the Future Runway 10R-28L Object Free Area (OFA). As a result, this pad will be restricted to aircraft having wingspans up to but not including 118 feet (ADG-III aircraft and smaller). While holding in the pad, there is sufficient clearance to ADG-V aircraft and smaller (having wingspans up to but not including 214 feet) on Taxiway S and/or an ADG-V aircraft located on the southern entrance taxiway to Runway 28L. Additionally, there is sufficient clearance for ADG-V aircraft to taxi on Taxiway S while another ADG-V aircraft is holding on the entrance taxiway to Runway 28L (hold line located 300 feet south of the Runway 28L centerline).

There are no dimensional changes planned for existing hold pads 14L, 32R, B-Pad, existing 9L pad and the 4L pad (Penalty Box). These pads will accommodate the holding of aircraft consistent with current use.

## **Appendix E: Summary of Future Runway 10R-28L Occupancy Time Analysis**

**PRELIMINARY DRAFT  
FOR DISCUSSION PURPOSES ONLY**

**Table 1**

REDIM Results Summary<sup>1/</sup>

	Runway Occupancy Times (seconds)	
	2013 Fleet Mix	2018 Fleet Mix
<b>Runway 10R<sup>2/</sup></b>		
3 Runway Exits (2 Highspeed and 1 @ 90°)	46.59	46.07
2 Runway Exits (1 Highspeed and 1 @ 90°)	48.36	47.85
<b>Runway 28L<sup>2/</sup></b>		
3 Runway Exits (2 Highspeed and 1 @ 90°)	43.39	43.26
2 Runway Exits (1 Highspeed and 1 @ 90°)	46.52	46.34

Note:

<sup>1/</sup> An exit speed of 27 meters per second (60 miles per hour) is assumed

<sup>2/</sup> Assumes 500 feet Runway to Taxiway separation

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Sources: ORD December 2002 ALP; FAA REDIM Model; Ricondo & Associates, Inc.

Prepared by: Ricondo & Associates, Inc.